

SECOND INTERIM REPORT

**TOTAL SYSTEM PERFORMANCE ASSESSMENT
PEER REVIEW PANEL**

DECEMBER 12, 1997

**Peer Review of the
Total System Performance Assessment - Viability Assessment**

Second Interim Report

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PREFACE

This report is the second in a series from the Performance Assessment Peer Review Panel. The Panel considers each successive report as an integral part of a series. Issues that have been covered previously will not be repeated unless new information or concerns arise.

In preparing this report, the Panel has directed its primary attention to the methods, data, and assumptions that have been developed or identified for the Total System Performance Assessment to be used in the Viability Assessment. The Panel's goals have been to note weaknesses that can be ameliorated through the use of more appropriate models and data, to seek clarification of the bases for certain of the analytical approaches and assumptions that have been used, and to evaluate the sensitivity analyses of alternative models and parameters and their associated uncertainties.

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EXECUTIVE SUMMARY

This second interim report of the Total System Performance Assessment Peer Review Panel (the Panel) reflects the Panel's activities since its first report was issued on June 20, 1997. Since this report was written to extend and expand on the earlier report, comments made at that time are not repeated here, except where the Panel is amplifying, extending, or revising its previous comments. For this reason, this report should be viewed as an extension of the first, not as a revision.

As was the case with the first report, the findings of the Panel are too extensive to be readily summarized in a brief Executive Summary. Nonetheless, two comments included in the Executive Summary of the first report are still relevant. Updated to reflect the content of this report, they are as follows:

- The Total System Performance Assessment (TSPA) supporting the Viability Assessment (VA) has not yet been completed and, thus, the Panel is reviewing a work in progress. The Panel has available to it previous TSPA reports and various technical documents prepared in support of the TSPA. Panel members also attended related project workshops, including several Technical Exchange meetings between the U.S. Department of Energy (DOE) and U.S. Nuclear Regulatory Commission (USNRC) staff. The observations made as a result of these meetings are included in this report.
- The design of the engineering features of the repository has evolved in several respects since the Panel began its review. For example, initially the inner corrosion resistant material for the waste canisters was specified as Alloy 825. During the first phase of our review, this was changed to Alloy 625. Although this is the current material specified in the reference design, an expanded program on waste package materials is underway, and a change in the reference design to the use of a C-22 alloy for the corrosion resistant material appears to be reasonably likely, based on discussions with project staff.

Since the Panel's first report was completed, more data have become available on specific radionuclides, ^{36}Cl in particular, in groundwater at the site. These data and related information have not yet been fully reconciled with the models of water flow in the unsaturated zone. In addition, the transport via groundwater of plutonium-bearing colloids has been identified and measured at the nearby Nevada Test Site. The interpretation of the significance of these measurements by the Project team has not yet been published.

During the past several months, the Panel has been able to review the current status of the Project staff's analyses of several issues not included in our initial report. As an outgrowth of these efforts, we have included in this second report more detailed comments on external events, such as volcanism, seismic events, and human intrusion.

We have also included comments regarding the assessment of the performance of waste glass, a topic not previously addressed.

In our first report, the Panel commented on how the TSPA-VA results could be made more transparent and accessible. In Section II of this report, we have included more extensive comments on the TSPA methodology, and addressed the limitations and uncertainties inherent in such an analysis. The Panel has also provided recommendations for improving the defensability of the TSPA-VA. These include recognizing (1) that the goal of the TSPA is not to predict the performance of the proposed repository, but rather to provide reasonable assurance on which to judge whether the standards and regulations are being met; and (2) that the models being used have significant limitations, including inevitable and inherent uncertainties in the resulting estimates of repository performance. To address these problems, the Panel recommends (1) that experiments be designed and conducted to test the accuracy and applicability of the near- and far-field models; (2) that limitations on the use and applications of expert elicitations be recognized; (3) that the design team recognize that the success of the safety case or “defense-in-depth” strategy depends on the functions and effectiveness of certain key components and/or elements within the system; and (4) that while the absence of an applicable U.S. Environmental Protection Agency standard and associated USNRC regulations does not pose an operational problem, the TSPA team needs to be aware that the performance measure that DOE has adopted includes a number of assumptions that may not prove to be correct.

An overview of this report is included in Section I, which immediately follows. The detailed findings of the Panel are presented in Section IV. Of these findings, two will be cited here. One is a concern on the part of the Panel that the TSPA team is not taking advantage of existing opportunities to test the validity of the models being used. One such opportunity would be to use the existing models to predict the results/data that will be generated through the Drift Scale Tests. Another, and more important concern, is that it may not be possible to analyze the impacts of certain postulated events on the performance of various systems and components within the proposed repository. This concern applies, in particular, to the responses of various systems to potential events, such as volcanism and criticality, and a thermal pulse. This concern includes details such as how a waste package might degrade under impacts of this nature. If the probabilities of the occurrence of volcanic events or the consequences of criticality are so low as to make them unimportant, then the question of analyzability in these two cases may become moot. This, however, may not be the case in terms of how the TSPA team will address the potential impacts of a thermal pulse. This is a difficult and perplexing problem. Careful thought needs to be given to how it is to be addressed.

I. INTRODUCTION

This introductory Section includes a discussion of the nature of the Total System Performance Assessment (TSPA) peer review process and provides a roadmap to the contents of this report.

A. Nature of TSPA Peer Review Process

In the Energy and Water Appropriations Act for fiscal year 1997, Congress specified four components of a viability assessment for a proposed high level radioactive waste repository at Yucca Mountain, Nevada. One of these was to complete:

...a total system performance assessment, based upon the design concept and the scientific data and analysis available by September 30, 1998, describing the probable behavior of the repository in the Yucca Mountain geological setting relative to the overall system performance standards.

The objective of the Total System Performance Assessment Peer Review is to provide a formal, independent evaluation and critique of the Total System Performance Assessment supporting the Viability Assessment (TSPA-VA) for the Civilian Radioactive Waste Management System Management and Operating contractor (CRWMS M&O). The TSPA-VA is being conducted by the CRWMS M&O for the U.S. Department of Energy (DOE) Yucca Mountain Site Characterization Office. The Performance Assessment Peer Review Panel (the Panel) has been asked to conduct a phased review over a two-year period during the development and completion of the TSPA-VA.

This is the second interim report of the Panel; a third report is scheduled to be issued prior to completion of the TSPA-VA. After the TSPA-VA is complete, the Panel will formally review it and prepare a final peer review report. A copy of the Plan for conducting the Performance Assessment Peer Review was presented in Appendix B of our first report (Whipple et al., 1997).

B. Content of Interim Reports

First Report

In its first report, submitted on June 20, 1997, the Panel:

- Provided an overview of the TSPA-VA approach and constraints, including the Panel's understanding of: (1) the use by the project staff of both detailed deterministic models and simplified abstraction models suitable for application in an integrated probabilistic analysis, (2) the repository and how it is intended to isolate wastes, and

(3) the approach taken by the project staff to assess performance in the absence of applicable standards by the U.S. Environmental Protection Agency (EPA) and accompanying regulations by the U.S. Nuclear Regulatory Commission (USNRC).

- Discussed in more detail its understanding of processes and events that would affect the future performance of a repository at Yucca Mountain and how they are being considered in the TSPA.
- Presented a summary of the Panel's major initial findings.

Second Report

Comments made in our first report are not repeated in this second report, except where the Panel is amplifying, extending, or revising its previous comments. For this reason, this second report should be viewed as an extension of the first, not as a revision.

Topics covered in this report fall into two general categories:

- General topics that were not covered in depth in the first report, for example, glass as a waste form and disruptive events other than criticality.
- Specific issues that the Panel has selected because of their potential significance to the results of the TSPA-VA.

This is not to indicate, however, that all significant issues have been covered. In some cases, the Panel was unable to comment because the supporting documentation does not exist. An example is the computational aspects of the TSPA-VA, including how uncertainties are propagated, how the number of runs needed to arrive at targeted confidence intervals was determined, and how the representation of complex models by simplified abstractions has been implemented. Where the Panel report includes comments on issues for which complete documentation is lacking, they are based on presentations by the Project team at various meetings and on conversations Panel members have had with Project staff.

The Panel's review has benefited from the clarity of recent documents issued by the M&O to describe the TSPA-VA. The document "Total System Performance Assessment - Viability Assessment (TSPA-VA) Methods and Assumptions" (CRWMS M&O 1997a) is particularly well written and provides a useful summary of the approaches the TSPA team plans to use. The Panel also continues to benefit from the cooperation and support of members of the CRWMS M&O staff.

In Section I of this report, the Panel provides an overview of the TSPA peer review process and our two initial reports.

In Section II, the Panel discusses its view of the role of the TSPA-VA, the expectations that may reasonably be set for the TSPA-VA, and how results are interpreted and limitations and uncertainties are addressed.

In Section III, the Panel describes in more detail its understanding of how the processes and events that could affect the future performance of a repository at Yucca Mountain are being analyzed in the TSPA. As in the first report, the organization of the discussion follows the major elements examined in the TSPA analysis: (1) initial conditions of the site; (2) conditions as affected by the repository; (3) isolation as provided by the waste form and the engineered barrier system; (4) disruptive events and criticality; (5) transport of radionuclides from the repository; and (6) the biosphere, doses, and health risks. (See Figure I-1)

In Section IV, the Panel presents a summary of the major findings that have been discussed in Sections II and III.

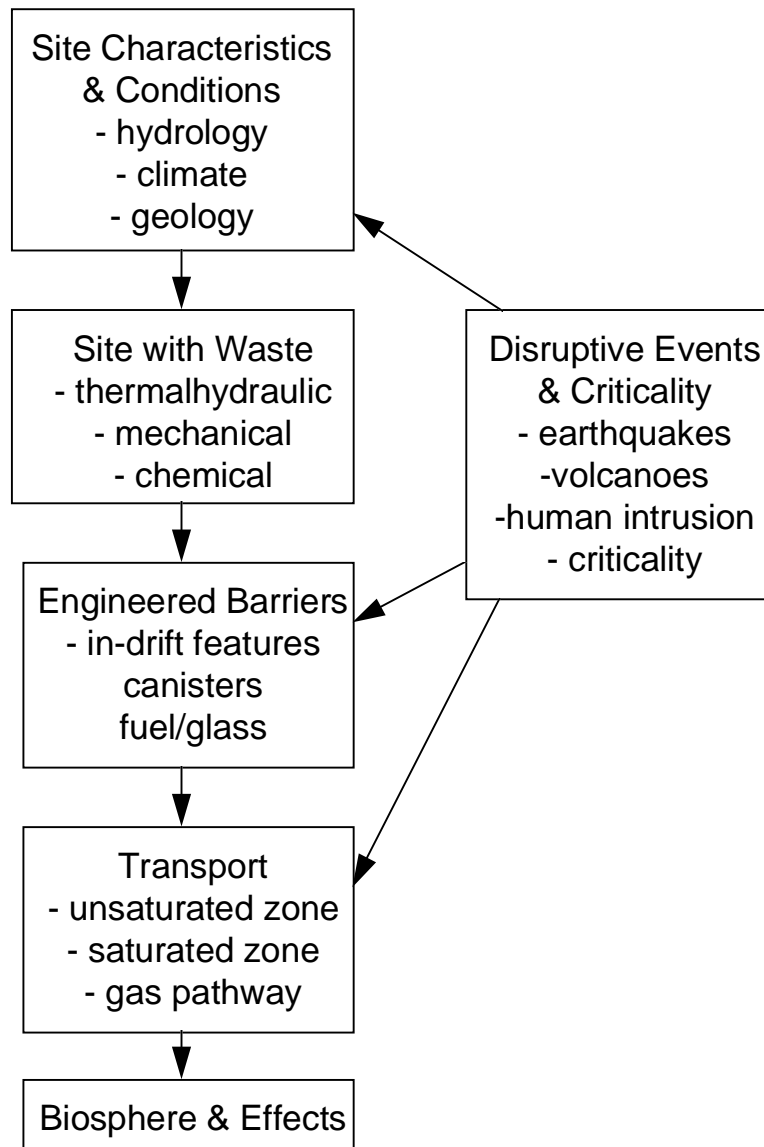


Figure I-1 -- Organization of TSPA-VA Peer Review